(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 October 2004 (28.10.2004)

PCT

(10) International Publication Number
WO 2004/092530 A2

(51) International Patent Classification[7]: E21B

(21) International Application Number: PCT/US2004/011177

(22) International Filing Date: 13 April 2004 (13.04.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/462,750 14 April 2003 (14.04.2003) US

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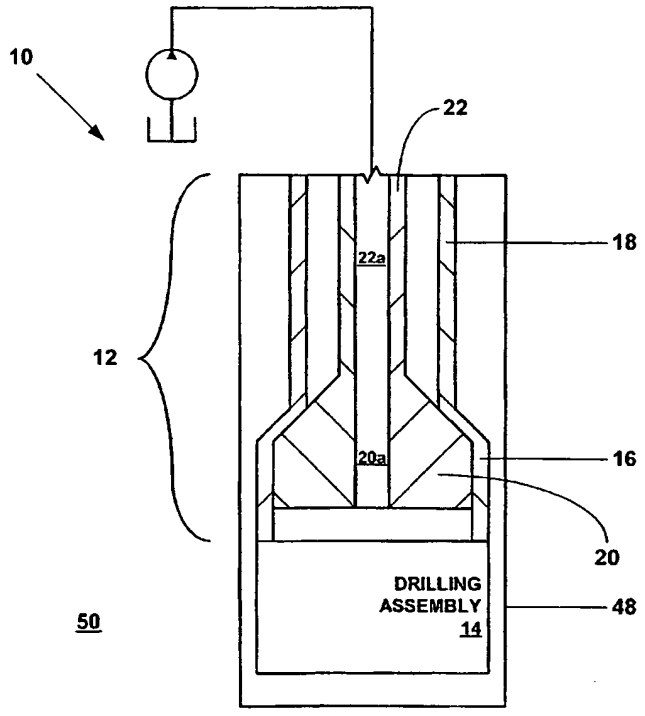
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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

*[Continued on next page]*

(54) Title: APPARATUS AND METHOD FOR RADIALLY EXPANDING A WELLBORE CASING AND DRILLING A WELLBORE

(57) Abstract: A method of radially expanding a wellbore casing and drilling a wellbore.




WO 2004/092530 A2

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Declaration under Rule 4.17:**

— *of inventorship (Rule 4.17(iv)) for US only*

**Published:**

— *without international search report and to be republished upon receipt of that report*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# APPARATUS AND METHOD FOR RADIALLY EXPANDING A WELLBORE CASING AND DRILLING A WELLBORE

## Cross Reference To Related Applications

**[001]** The present application claims the benefit of the filing date of U.S. provisional patent application serial no. 60/462,750, attorney docket no. 25791.193, filed on April 14, 2003, the disclosure of which is incorporated herein by reference.

**[002]** This application is a continuation-in-part of one or more of the following: 1) U.S. utility patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on March 10,2000, 2) U.S. utility patent application serial no. 09/962,469, attorney docket no. 25791.62, filed on 9/25/2001, 3) U.S. utility patent application serial no. 09/962,470, attorney docket no. 25791.63, filed on 9/25/2001, 4) U.S. utility patent application serial no. 09/962,471, attorney docket no. 25791.64, filed on 9/25/2001, 5) U.S. utility patent application serial no. 09/962,467, attorney docket no. 25791.65, filed on 9/25/2001, 6) U.S. utility patent application serial no. 09/962,468, attorney docket no. 25791.66, filed on 9/25/2001, 7) U.S. utility patent application serial no. 10/421,682, attorney docket no. 25791.256, filed on 4/23/2003, and 8) U.S. utility patent application serial no. 10/418,688, attorney docket no. 25791.257, filed on 4/18/2003, the disclosures of which are incorporated herein by reference.

**[003]** The present application is related to the following: (1) U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, which claims priority from provisional application 60/121,702, filed on 2/25/99, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, which claims priority from provisional application 60/119,611, filed on 2/11/99, (4) U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (5) U.S. patent application serial no. 10/169,434, attorney docket no. 25791.10.04, filed on 7/1/02, which claims priority from provisional application 60/183,546, filed on 2/18/00, (6) U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (7) U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (8) U.S. patent number 6,575,240, which was filed as patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, which claims priority from provisional application 60/121,907, filed on 2/26/99, (9)

U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (10) U.S. patent application serial no. 09/981,916, attorney docket no. 25791.18, filed on 10/18/01 as a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (11) U.S. patent number 6,604,763, which was filed as application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, which claims priority from provisional application 60/131,106, filed on 4/26/99, (12) U.S. patent application serial no. 10/030,593, attorney docket no. 25791.25.08, filed on 1/8/02, which claims priority from provisional application 60/146,203, filed on 7/29/99, (13) U.S. provisional patent application serial no. 60/143,039, attorney docket no. 25791.26, filed on 7/9/99, (14) U.S. patent application serial no. 10/111,982, attorney docket no. 25791.27.08, filed on 4/30/02, which claims priority from provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (15) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (16) U.S. provisional patent application serial no. 60/438,828, attorney docket no. 25791.31, filed on 1/9/03, (17) U.S. patent number 6,564,875, which was filed as application serial no. 09/679,907, attorney docket no. 25791.34.02, on 10/5/00, which claims priority from provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (18) U.S. patent application serial no. 10/089,419, filed on 3/27/02, attorney docket no. 25791.36.03, which claims priority from provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (19) U.S. patent application serial no. 09/679,906, filed on 10/5/00, attorney docket no. 25791.37.02, which claims priority from provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (20) U.S. patent application serial no. 10/303,992, filed on 11/22/02, attorney docket no. 25791.38.07, which claims priority from provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (21) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (22) U.S. provisional patent application serial no. 60/455,051, attorney docket no. 25791.40, filed on 3/14/03, (23) PCT application US02/2477, filed on 6/26/02, attorney docket no. 25791.44.02, which claims priority from U.S. provisional patent application serial no. 60/303,711, attorney docket no. 25791.44, filed on 7/6/01, (24) U.S. patent application serial no. 10/311,412, filed on 12/12/02, attorney docket no. 25791.45.07, which claims priority from provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (25) U.S. patent application serial no. 10/, filed on 12/18/02, attorney docket no. 25791.46.07, which claims priority from provisional patent application

serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (26) U.S. patent application serial no. 10/322,947, filed on 1/22/03, attorney docket no. 25791.47.03, which claims priority from provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (27) U.S. patent application serial no. 10/406,648, filed on 3/31/03, attorney docket no. 25791.48.06, which claims priority from provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (28) PCT application US02/04353, filed on 2/14/02, attorney docket no. 25791.50.02, which claims priority from U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (29) U.S. patent application serial no. 10/465,835, filed on 6/13/03, attorney docket no. 25791.51.06, which claims priority from provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (30) U.S. patent application serial no. 10/465,831, filed on 6/13/03, attorney docket no. 25791.52.06, which claims priority from U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (31) U.S. provisional patent application serial no. 60/452,303, filed on 3/5/03, attorney docket no. 25791.53, (32) U.S. patent number 6,470,966, which was filed as patent application serial number 09/850,093, filed on 5/7/01, attorney docket no. 25791.55, as a divisional application of U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (33) U.S. patent number 6,561,227, which was filed as patent application serial number 09/852,026 , filed on 5/9/01, attorney docket no. 25791.56, as a divisional application of U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (34) U.S. patent application serial number 09/852,027, filed on 5/9/01, attorney docket no. 25791.57, as a divisional application of U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (35) PCT Application US02/25608, attorney docket no. 25791.58.02, filed on 8/13/02, which claims priority from provisional application 60/318,021, filed on 9/7/01, attorney docket no. 25791.58, (36) PCT Application US02/24399, attorney docket no. 25791.59.02, filed on 8/1/02, which claims priority from U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (37) PCT Application US02/29856, attorney docket no. 25791.60.02, filed on 9/19/02, which claims priority from U.S. provisional patent application serial no. 60/326,886, attorney docket no. 25791.60, filed on 10/3/2001, (38) PCT Application US02/20256, attorney docket no. 25791.61.02, filed on 6/26/02, which claims priority from U.S. provisional patent application serial no. 60/303,740, attorney docket no.

25791.61, filed on 7/6/2001, (39) U.S. patent application serial no. 09/962,469, filed on 9/25/01, attorney docket no. 25791.62, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (40) U.S. patent application serial no. 09/962,470, filed on 9/25/01, attorney docket no. 25791.63, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (41) U.S. patent application serial no. 09/962,471, filed on 9/25/01, attorney docket no. 25791.64, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (42) U.S. patent application serial no. 09/962,467, filed on 9/25/01, attorney docket no. 25791.65, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (43) U.S. patent application serial no. 09/962,468, filed on 9/25/01, attorney docket no. 25791.66, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (44) PCT application US 02/25727, filed on 8/14/02, attorney docket no. 25791.67.03, which claims priority from U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, and U.S. provisional patent application serial no. 60/318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (45) PCT application US 02/39425, filed on 12/10/02, attorney docket no. 25791.68.02, which claims priority from U.S. provisional patent application serial no. 60/343,674 , attorney docket no. 25791.68, filed on 12/27/2001, (46) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, which is a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (47) U.S. utility patent application serial no. 10/516,467, attorney docket no. 25791.70, filed on 12/10/01, which is a continuation application of U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, which is a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (48) PCT application US 03/00609, filed on 1/9/03, attorney docket no. 25791.71.02, which claims priority from U.S. provisional patent application serial no. 60/357,372 , attorney docket no. 25791.71, filed on 2/15/02, (49) U.S. patent application serial no. 10/074,703, attorney docket no. 25791.74, filed on 2/12/02,

which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (50) U.S. patent application serial no. 10/074,244, attorney docket no. 25791.75, filed on 2/12/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (51) U.S. patent application serial no. 10/076,660, attorney docket no. 25791.76, filed on 2/15/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (52) U.S. patent application serial no. 10/076,661, attorney docket no. 25791.77, filed on 2/15/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (53) U.S. patent application serial no. 10/076,659, attorney docket no. 25791.78, filed on 2/15/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (54) U.S. patent application serial no. 10/078,928, attorney docket no. 25791.79, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (55) U.S. patent application serial no. 10/078,922, attorney docket no. 25791.80, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (56) U.S. patent application serial no. 10/078,921, attorney docket no. 25791.81, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (57) U.S. patent application serial no. 10/261,928, attorney docket no. 25791.82, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (58) U.S. patent application serial no. 10/079,276 , attorney docket no. 25791.83, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on

2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (59) U.S. patent application serial no. 10/262,009, attorney docket no. 25791.84, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (60) U.S. patent application serial no. 10/092,481, attorney docket no. 25791.85, filed on 3/7/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (61) U.S. patent application serial no. 10/261,926, attorney docket no. 25791.86, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (62) PCT application US 02/36157, filed on 11/12/02, attorney docket no. 25791.87.02, which claims priority from U.S. provisional patent application serial no. 60/338,996, attorney docket no. 25791.87, filed on 11/12/01, (63) PCT application US 02/36267, filed on 11/12/02, attorney docket no. 25791.88.02, which claims priority from U.S. provisional patent application serial no. 60/339,013, attorney docket no. 25791.88, filed on 11/12/01, (64) PCT application US 03/11765, filed on 4/16/03, attorney docket no. 25791.89.02, which claims priority from U.S. provisional patent application serial no. 60/383,917, attorney docket no. 25791.89, filed on 5/29/02, (65) PCT application US 03/15020, filed on 5/12/03, attorney docket no. 25791.90.02, which claims priority from U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/02, (66) PCT application US 02/39418, filed on 12/10/02, attorney docket no. 25791.92.02, which claims priority from U.S. provisional patent application serial no. 60/346,309, attorney docket no. 25791.92, filed on 1/7/02, (67) PCT application US 03/06544, filed on 3/4/03, attorney docket no. 25791.93.02, which claims priority from U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/02, (68) U.S. patent application serial no. 10/331,718, attorney docket no. 25791.94, filed on 12/30/02, which is a divisional U.S. patent application serial no. 09/679,906, filed on 10/5/00, attorney docket no. 25791.37.02, which claims priority from provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (69) PCT application US 03/04837, filed on 2/29/03, attorney docket no. 25791.95.02, which claims priority from U.S. provisional patent application serial no. 60/363,829, attorney docket no. 25791.95, filed on 3/13/02, (70) U.S. patent application serial no. 10/261,927, attorney docket no. 25791.97, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998,

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## Background of the Invention

**[004]** This invention relates generally to oil and gas exploration, and in particular to forming and repairing wellbore casings to facilitate oil and gas exploration.

**[005]** Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

**[006]** The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming and/or repairing wellbore casings.

## Summary of the Invention

**[007]** According to one aspect of the present invention, an apparatus for radially expanding a tubular member and drilling a wellbore within a subterranean formation is provided that includes an expandable tubular member, an expansion device coupled to the expandable tubular member adapted to radially expand and plastically deform the expandable tubular member within the wellbore including: a tubular expansion mandrel, and a tubular expansion mandrel launcher for housing the tubular expansion mandrel coupled to the expandable tubular member, a pump coupled to the expansion device adapted to pump fluidic materials through the tubular expansion mandrel into a portion of the tubular expansion mandrel launcher, a drilling device coupled to the expansion device adapted to receive the fluidic materials pumped into the portion of the tubular expansion mandrel launcher and drill the

wellbore within the subterranean formation including: one or more flow control elements for controlling the flow of the received fluidic materials, a motor coupled to the flow control elements adapted to be operated by the fluidic materials, and a drill coupled to the motor adapted to be driven by the motor, and a controller coupled to the expansion device and the drilling device that is programmed to control the expansion device and the drilling device to operate in one of the following modes of operation: (a) drilling the wellbore using the drilling device or expanding the tubular member using the expansion device, or (b) drilling the wellbore using the drilling device and expanding the tubular member using the expansion device simultaneously.

**[008]** According to another aspect of the present invention, a method of radially expanding a wellbore casing within a wellbore and drilling the wellbore through a subterranean formation is provided that includes positioning an expandable casing, an expansion device for radially expanding the expandable casing, and a drilling device for extending the wellbore within the wellbore, and operating the expansion device and the drilling device using a method including: selecting drilling or expanding or drilling and expanding, if drilling or expanding is selected, then sequentially performing the following steps in any order: extending the wellbore using the drilling device, and expanding the casing using the expansion device, and if drilling and expanding is selected, then simultaneously performing the following steps: extending the wellbore using the drilling device, and expanding the casing using the expansion device.

**[009]** According to another aspect of the present invention, a system for radially expanding a wellbore casing within a wellbore and drilling the wellbore through a subterranean formation is provided that includes means for positioning an expandable casing, an expansion device for radially expanding the expandable casing, and a drilling device for extending the wellbore within the wellbore, and means for operating the expansion device and the drilling device including: means for selecting drilling or expanding or drilling and expanding, if drilling or expanding is selected, then means for sequentially performing the following steps in any order: extending the wellbore using the drilling device, and expanding the casing using the expansion device, and if drilling and expanding is selected, then means for simultaneously performing the following steps: extending the wellbore using the drilling device, and expanding the casing using the expansion device.

**[0010]** According to another aspect of the present invention, an apparatus for radially expanding a tubular member and drilling a wellbore within a subterranean formation is provided that includes an expandable tubular member, an expansion device coupled to the expandable tubular member adapted to radially expand and plastically deform the expandable tubular member within the wellbore, a drilling device coupled to the expansion device adapted to drill the wellbore within the subterranean formation, and a controller

coupled to the expansion device and the drilling device that is programmed to control the expansion device and the drilling device to operate in one of the following modes of operation: (a) drilling the wellbore using the drilling device or expanding the tubular member using the expansion device; or (b) drilling the wellbore using the drilling device and expanding the tubular member using the expansion device simultaneously.

## Brief Description of the Drawings

**[0011]** Figs. 1a, 1ba, 1bb, 1bc, 1bd, 1be, 1bf, 1c, and 1d are fragmentary cross sectional illustrations of an exemplary embodiment of an apparatus for radially expanding a wellbore casing and drilling a borehole within a subterranean formation.

**[0012]** Fig. 1e is a schematic illustration of the apparatus of Figs. 1a, 1ba, 1bb, 1bc, 1bd, 1be, 1bf, 1c, and 1d.

**[0013]** Figs. 2a, 2b, and 2c are an exemplary embodiment of a method of operating the apparatus of Figs. 1a, 1ba, 1bb, 1bc, 1bd, 1be, 1bf, 1c, and 1d.

## Detailed Description of the Illustrative Embodiments

**[0014]** Referring to Figs. 1a, 1b, 1ca, 1cb, 1cc, 1cd, 1ce, 1cf, and 1d, an exemplary embodiment of a system 10 for radially expanding a casing and drilling a wellbore includes a casing expansion assembly 12 that is coupled to a wellbore drilling assembly 14.

**[0015]** The casing expansion assembly 12 includes a tubular expansion mandrel launcher 16 and an expandable tubular casing 18 that is coupled to an upper end of the tubular expansion mandrel launcher, and a lower end of the tubular expansion mandrel launcher 16 is coupled to an upper end of the drilling assembly 14. In an exemplary embodiment, the tubular expansion mandrel launcher 16 includes a lower portion 16a, an upper portion 16b, and an intermediate tapered portion 16c that is coupled to and positioned between ends of the lower and upper portions.

**[0016]** A tubular expansion mandrel 20 that defines a passage 20a and includes an outer tapered expansion surface 20b is positioned within the tubular expansion mandrel launcher 16, and an end of a tubular support member 22 that defines a passage 22a is coupled to an upper end of the tubular expansion mandrel 20.

**[0017]** The drilling assembly 14 includes a funnel cross over 24 that defines a passage 24a and includes an upper tubular portion 24b that coupled to the lower tubular portion 16a of the tubular expansion mandrel launcher 16, a lower tubular portion 24c, and an intermediate tapered tubular portion 24e that is coupled to and positioned between the upper and lower tubular portions. In an exemplary embodiment, a flow element 26 that defines a passage 26a may be positioned within and coupled to the lower tubular portion 24c of the funnel cross over 24. The flow element 26 may further include one or more of the following types of flow elements: orifices 26b, nozzles 26c, passive flow elements 26d, and/or active flow elements 26e for controlling the flow of fluidic materials through the passage 26a.

**[0018]** An upper end of a conventional pup joint 28 that defines a passage 28a is coupled to the lower tubular portion 24c of the funnel cross over 24. A lower end of the conventional pup joint 28 is coupled to an upper end of a bi-pressure sub 30 that defines a passage 30a and includes a flow control element 30b for controlling the flow of fluidic materials through the passage 30a. In an exemplary embodiment, the flow control element 30b is coupled to a controller 32 and is adapted to permit anywhere from 0 to 100% flow through the passage 30a under the control of the controller. In an exemplary embodiment, the bi-pressure sub is provided by modifying a conventional adjustable gauge stabilizer in accordance with the teachings of the present disclosure.

**[0019]** An upper end of a conventional shock tool 34 that defines a passage 34a is coupled to a lower end of the bi-pressure sub 30, and a lower end of the conventional shock tool is coupled to an upper end of a conventional mud motor 36 that defines a passage 36a. A lower end of the conventional mud motor 36 is coupled to an upper end of a conventional cross-over 38 that defines a passage 38a, and a lower end of the conventional cross-over is coupled to an upper end of a conventional underreamer 40 that defines a passage 40a. A lower end of the conventional underreamer is coupled to an upper end of a conventional string stabilizer 42 that defines a passage 42a, and a lower end of the string stabilizer is coupled to an upper end of a near bit stabilizer 44 that defines a passage 44a. A lower end of the near bit stabilizer is coupled to an upper end of a conventional drill bit 46 that defines a passage 46a.

**[0020]** The design and operation of the pup joint 28, the shock tool 34, mud motor 36, the cross over 38, the underreamer 40, the string stabilizer 42, the near bit stabilizer 44, and the bit 46 are considered well known to persons having ordinary skill in the art. Furthermore, the connectivity and cooperative functionality of the pup joint 28, the shock tool 34, mud motor 36, the cross over 38, the underreamer 40, the string stabilizer 42, the near bit stabilizer 44, and the bit 46 are also considered to be well known to persons having ordinary skill in the art. In several exemplary embodiments, the underreamer 40 and/or the drill bit 46 are at least partially operated in a conventional manner by the fluid pressure within the passages 40a and/or 46a.

**[0021]** As illustrated in Fig. 1e, in an exemplary embodiment, the pump 23 is operably coupled to the interior portion of the launcher 16 below the expansion mandrel 20. In this manner, the pump 23 may pressurize the interior portion of the launcher 16 and/or casing 18 below the expansion mandrel 20. The mud motor 36 is controllably coupled to the pump 23 by the flow elements 26 and the flow control valve 30b. In this manner, the mud motor 36, the underreamer 40, and the drill bit 46 may be controllably operated during the operation of the pump 23. In an exemplary embodiment, the flow elements 26 are selected to define the operational characteristics of the system 10 such as, for example, the frequency response

characteristics of the system. In an exemplary embodiment, the flow control valve 30b may be controllably positioned by the controller 32 to any position from fully open to fully closed.

**[0022]** In an exemplary embodiment, the operating pressure within the interior portion of the launcher 16 and/or casing 18 below the expansion mandrel 20 may be increased by decreasing the flow rate of fluidic materials through the flow elements 26 and/or the flow control valve 30b. As a result, the back pressure in the system 10 is increased. The decreased flow rate through the flow elements 26 may, for example, be caused by the selected frequency response, or other operational, characteristics of the flow elements. For example, the pump 23 may be operated to generate a pressure or flow signal that causes the resistance to flow of the flow elements 26 to increase, or the active flow elements 26d of the flow elements may be operated to increase the resistance to flow. The decreased flow rate through the flow control valve 30b may be caused by operating the controller 32 to decrease the opening position of the flow control valve. The resulting decreased flow rate of fluidic materials through the flow elements 26 and/or the flow control valve 30b in turn will increase the operating pressure in the flow passages and pressure chambers upstream of the flow elements 26 and/or control valve 30b within the system 10. As a result, the expansion mandrel 20 may be displaced upwardly relative to the launcher 16 and/or casing 18 thereby causing the expansion mandrel to radially expand and plastically deform the launcher and/or casing.

**[0023]** In an exemplary embodiment, the operating pressure within the interior portion of the launcher 16 and/or casing 18 below the expansion mandrel 20 may be decreased by increasing the flow rate of fluidic materials through the flow elements 26 and/or the flow control valve 30b. As a result, the back pressure in the system 10 is decreased. The increased flow rate through the flow elements 26 may, for example, be caused by the frequency response, or other operational, characteristics of the flow elements. For example, the pump 23 may be operated to generate a pressure or flow signal that causes the resistance to flow of the flow elements to decrease, or the active flow elements 26d of the flow elements may be operated to decrease the resistance to flow. The increased flow rate through the flow control valve 30b may be caused by operating the controller 32 to increase the opening position of the flow control valve. The resulting increased flow rate of fluidic materials through the flow elements 26 and/or the flow control valve 30b in turn will decrease the operating pressure in the flow passages and pressure chambers upstream of the flow elements 26 and/or control valve 30b within the system 10. As a result, the expansion mandrel 20 may not be displaced upwardly relative to the launcher 16 and/or casing 18 thereby the radial expansion and plastic deformation of the launcher and/or casing caused by the expansion mandrel may be decreased or stopped.

**[0024]** In an exemplary embodiment, increasing the flow rate of fluidic materials through the flow elements 26 and/or the flow control valve 30b will increase the operation of the mud motor 36, the underreamer 40, and the drill bit 46. Alternatively, in an exemplary embodiment, decreasing the flow rate of fluidic materials through the flow elements 26 and/or the flow control valve 30b will decrease the operation of the mud motor 36, the underreamer 40, and the drill bit 46.

**[0025]** In an exemplary embodiment, the system 10 is initially positioned within a wellbore 48 that traverses a subterranean formation 50. Referring to Fig. 2a, 2b, and 2c, in an exemplary embodiment, the system 10 then implements a method of operation 200 in which the operator of the system 10 may select one of the following modes of operation in step 202: (a) drilling or expansion operation; or (b) drilling and expansion operation. In an exemplary embodiment, the drilling or expansion operation permits the system 10 to drill the wellbore 48 or radially expand and plastically deform the casing 18, and the drilling and expansion operation permits the system 10 to simultaneously drill the wellbore and radially expand and plastically deform the casing.

**[0026]** If the operator selects the drilling or expansion operation in step 202, then the operator may then select drilling or expansion in step 204. If the operator selects drilling in step 204, then fluidic materials are injected into the system 10 through the passages 20a, 22a, 24a, 28a, 30a, 32a, 34a, 36a, 38a, 40a, 42a, 44a, and 46a in step 206, and the controller 32 then operates the flow control element 30b to decrease the back pressure in the passage 30a sufficiently to operate the underreamer 40 and/or the drill bit 46 in a conventional manner and thereby permit the extension of the wellbore 48 in step 208. If the operator does not want to continue drilling in step 210, then the injection of fluidic materials into the system 10 through the passages through the passages 20a, 22a, 24a, 28a, 30a, 32a, 34a, 36a, 38a, 40a, 42a, 44a, and 46a is stopped in step 212.

**[0027]** If the operator does not want to continue the drilling or expansion operation in step 214, then the operation of the system 10 is stopped. Alternatively, if the operator does want to continue the drilling or expansion operation in step 214, the operator may then select drilling or expansion in step 204.

**[0028]** If the operator selects expansion in step 204, then fluidic materials are injected into the system 10 through the passages 20a, 22a, 24a, 28a, 30a, 32a, 34a, 36a, 38a, 40a, 42a, 44a, and 46a in step 216, and the controller 32 then operates the flow control element 30b to increase the back pressure in the passage 30a sufficiently to pressurize the interior portion of the portion of the expansion mandrel launcher 16 and/or the casing 18 below the expansion mandrel 20 to displace the expansion mandrel upwardly relative to the launcher and/or casing to thereby permit the radial expansion and plastic deformation of the launcher and/or casing in step 218. If the operator does not want to continue expansion in step 220,

then the injection of fluidic materials into the system 10 through the passages through the passages 20a, 22a, 24a, 28a, 30a, 32a, 34a, 36a, 38a, 40a, 42a, 44a, and 46a is stopped in step 222.

**[0029]** If the operator selects the drilling and expansion operation in step 202, then fluidic materials are injected into the system 10 through the passages 20a, 22a, 24a, 28a, 30a, 32a, 34a, 36a, 38a, 40a, 42a, 44a, and 46a in step 224, and the controller 32 then operates the flow control element 30b to adjust the back pressure in the passage 30a to simultaneously (a) operate the underreamer 40 and/or the drill bit 46 is a conventional manner and thereby permit the extension of the wellbore 48; and (b) pressurize the interior portion of the portion of the expansion mandrel launcher 16 and/or casing 18 below the expansion mandrel 20 to displace the expansion mandrel upwardly relative to the launcher and/or casing to thereby permit the radial expansion and plastic deformation of the launcher and/or casing in step 228.

**[0030]** If the operator does not want to continue the drilling and expansion operation in step 228, then the injection of fluidic materials into the system 10 through the passages through the passages 20a, 22a, 24a, 28a, 30a, 32a, 34a, 36a, 38a, 40a, 42a, 44a, and 46a is stopped in step 230 and the operation of the system 10 is stopped.

**[0031]** In several alternative embodiments, the exemplary embodiments of Figs. 1a, 1ba, 1bb, 1bc, 1bd, 1be, 1bf, 1c, 1d, 1e, 2a, 2b, and 2c are implemented using the methods and/or apparatus disclosed one or more of the following: (1) U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, which claims priority from provisional application 60/121,702, filed on 2/25/99, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, which claims priority from provisional application 60/119,611, filed on 2/11/99, (4) U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (5) U.S. patent application serial no. 10/169,434, attorney docket no. 25791.10.04, filed on 7/1/02, which claims priority from provisional application 60/183,546, filed on 2/18/00, (6) U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (7) U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (8) U.S. patent number 6,575,240, which was filed as patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on

2/24/2000, which claims priority from provisional application 60/121,907, filed on 2/26/99, (9) U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (10) U.S. patent application serial no. 09/981,916, attorney docket no. 25791.18, filed on 10/18/01 as a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (11) U.S. patent number 6,604,763, which was filed as application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, which claims priority from provisional application 60/131,106, filed on 4/26/99, (12) U.S. patent application serial no. 10/030,593, attorney docket no. 25791.25.08, filed on 1/8/02, which claims priority from provisional application 60/146,203, filed on 7/29/99, (13) U.S. provisional patent application serial no. 60/143,039, attorney docket no. 25791.26, filed on 7/9/99, (14) U.S. patent application serial no. 10/111,982, attorney docket no. 25791.27.08, filed on 4/30/02, which claims priority from provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (15) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (16) U.S. provisional patent application serial no. 60/438,828, attorney docket no. 25791.31, filed on 1/9/03, (17) U.S. patent number 6,564,875, which was filed as application serial no. 09/679,907, attorney docket no. 25791.34.02, on 10/5/00, which claims priority from provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (18) U.S. patent application serial no. 10/089,419, filed on 3/27/02, attorney docket no. 25791.36.03, which claims priority from provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (19) U.S. patent application serial no. 09/679,906, filed on 10/5/00, attorney docket no. 25791.37.02, which claims priority from provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (20) U.S. patent application serial no. 10/303,992, filed on 11/22/02, attorney docket no. 25791.38.07, which claims priority from provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (21) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (22) U.S. provisional patent application serial no. 60/455,051, attorney docket no. 25791.40, filed on 3/14/03, (23) PCT application US02/2477, filed on 6/26/02, attorney docket no. 25791.44.02, which claims priority from U.S. provisional patent application serial no. 60/303,711, attorney docket no. 25791.44, filed on 7/6/01, (24) U.S. patent application serial no. 10/311,412, filed on 12/12/02, attorney docket no. 25791.45.07, which claims priority from provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (25) U.S. patent application serial no. 10/, filed on 12/18/02,

attorney docket no. 25791.46.07, which claims priority from provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (26) U.S. patent application serial no. 10/322,947, filed on 1/22/03, attorney docket no. 25791.47.03, which claims priority from provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (27) U.S. patent application serial no. 10/406,648, filed on 3/31/03, attorney docket no. 25791.48.06, which claims priority from provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (28) PCT application US02/04353, filed on 2/14/02, attorney docket no. 25791.50.02, which claims priority from U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (29) U.S. patent application serial no. 10/465,835, filed on 6/13/03, attorney docket no. 25791.51.06, which claims priority from provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (30) U.S. patent application serial no. 10/465,831, filed on 6/13/03, attorney docket no. 25791.52.06, which claims priority from U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (31) U.S. provisional patent application serial no. 60/452,303, filed on 3/5/03, attorney docket no. 25791.53, (32) U.S. patent number 6,470,966, which was filed as patent application serial number 09/850,093, filed on 5/7/01, attorney docket no. 25791.55, as a divisional application of U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (33) U.S. patent number 6,561,227, which was filed as patent application serial number 09/852,026 , filed on 5/9/01, attorney docket no. 25791.56, as a divisional application of U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (34) U.S. patent application serial number 09/852,027, filed on 5/9/01, attorney docket no. 25791.57, as a divisional application of U.S. Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (35) PCT Application US02/25608, attorney docket no. 25791.58.02, filed on 8/13/02, which claims priority from provisional application 60/318,021, filed on 9/7/01, attorney docket no. 25791.58, (36) PCT Application US02/24399, attorney docket no. 25791.59.02, filed on 8/1/02, which claims priority from U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (37) PCT Application US02/29856, attorney docket no. 25791.60.02, filed on 9/19/02, which claims priority from U.S. provisional patent application serial no. 60/326,886, attorney docket no. 25791.60, filed on 10/3/2001, (38) PCT Application US02/20256, attorney docket no. 25791.61.02, filed on 6/26/02, which claims

priority from U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (39) U.S. patent application serial no. 09/962,469, filed on 9/25/01, attorney docket no. 25791.62, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (40) U.S. patent application serial no. 09/962,470, filed on 9/25/01, attorney docket no. 25791.63, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (41) U.S. patent application serial no. 09/962,471, filed on 9/25/01, attorney docket no. 25791.64, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (42) U.S. patent application serial no. 09/962,467, filed on 9/25/01, attorney docket no. 25791.65, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (43) U.S. patent application serial no. 09/962,468, filed on 9/25/01, attorney docket no. 25791.66, which is a divisional of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (44) PCT application US 02/25727, filed on 8/14/02, attorney docket no. 25791.67.03, which claims priority from U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, and U.S. provisional patent application serial no. 60/318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (45) PCT application US 02/39425, filed on 12/10/02, attorney docket no. 25791.68.02, which claims priority from U.S. provisional patent application serial no. 60/343,674 , attorney docket no. 25791.68, filed on 12/27/2001, (46) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, which is a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (47) U.S. utility patent application serial no. 10/516,467, attorney docket no. 25791.70, filed on 12/10/01, which is a continuation application of U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, which is a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (48) PCT application US 03/00609, filed on 1/9/03, attorney docket no. 25791.71.02, which claims priority from U.S. provisional patent application serial no. 60/357,372 , attorney docket no. 25791.71, filed on 2/15/02, (49) U.S.

patent application serial no. 10/074,703, attorney docket no. 25791.74, filed on 2/12/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (50) U.S. patent application serial no. 10/074,244, attorney docket no. 25791.75, filed on 2/12/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (51) U.S. patent application serial no. 10/076,660, attorney docket no. 25791.76, filed on 2/15/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (52) U.S. patent application serial no. 10/076,661, attorney docket no. 25791.77, filed on 2/15/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (53) U.S. patent application serial no. 10/076,659, attorney docket no. 25791.78, filed on 2/15/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (54) U.S. patent application serial no. 10/078,928, attorney docket no. 25791.79, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (55) U.S. patent application serial no. 10/078,922, attorney docket no. 25791.80, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (56) U.S. patent application serial no. 10/078,921, attorney docket no. 25791.81, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (57) U.S. patent application serial no. 10/261,928, attorney docket no. 25791.82, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (58) U.S. patent application serial no. 10/079,276 , attorney docket no. 25791.83, filed on 2/20/02, which is a divisional of U.S. patent number 6,568,471, which was

filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (59) U.S. patent application serial no. 10/262,009, attorney docket no. 25791.84, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (60) U.S. patent application serial no. 10/092,481, attorney docket no. 25791.85, filed on 3/7/02, which is a divisional of U.S. patent number 6,568,471, which was filed as patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, which claims priority from provisional application 60/121,841, filed on 2/26/99, (61) U.S. patent application serial no. 10/261,926, attorney docket no. 25791.86, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (62) PCT application US 02/36157, filed on 11/12/02, attorney docket no. 25791.87.02, which claims priority from U.S. provisional patent application serial no. 60/338,996, attorney docket no. 25791.87, filed on 11/12/01, (63) PCT application US 02/36267, filed on 11/12/02, attorney docket no. 25791.88.02, which claims priority from U.S. provisional patent application serial no. 60/339,013, attorney docket no. 25791.88, filed on 11/12/01, (64) PCT application US 03/11765, filed on 4/16/03, attorney docket no. 25791.89.02, which claims priority from U.S. provisional patent application serial no. 60/383,917, attorney docket no. 25791.89, filed on 5/29/02, (65) PCT application US 03/15020, filed on 5/12/03, attorney docket no. 25791.90.02, which claims priority from U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/02, (66) PCT application US 02/39418, filed on 12/10/02, attorney docket no. 25791.92.02, which claims priority from U.S. provisional patent application serial no. 60/346,309, attorney docket no. 25791.92, filed on 1/7/02, (67) PCT application US 03/06544, filed on 3/4/03, attorney docket no. 25791.93.02, which claims priority from U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/02, (68) U.S. patent application serial no. 10/331,718, attorney docket no. 25791.94, filed on 12/30/02, which is a divisional U.S. patent application serial no. 09/679,906, filed on 10/5/00, attorney docket no. 25791.37.02, which claims priority from provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (69) PCT application US 03/04837, filed on 2/29/03, attorney docket no. 25791.95.02, which claims priority from U.S. provisional patent application serial no. 60/363,829, attorney docket no. 25791.95, filed on 3/13/02, (70) U.S. patent application serial no. 10/261,927, attorney docket no. 25791.97, filed on 10/1/02, which is a divisional of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no.

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Patent Number 6,497,289, which was filed as U.S. Patent Application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, which claims priority from provisional application 60/111,293, filed on 12/7/98, (85) U.S. provisional patent application serial no. 60/412,177, attorney docket no. 25791.117, filed on 9/20/02, (86) U.S. provisional patent application serial no. 60/412,653, attorney docket no. 25791.118, filed on 9/20/02, (87) U.S. provisional patent application serial no. 60/405,610, attorney docket no. 25791.119, filed on 8/23/02, (88) U.S. provisional patent application serial no. 60/405,394, attorney docket no. 25791.120, filed on 8/23/02, (89) U.S. provisional patent application serial no. 60/412,544, attorney docket no. 25791.121, filed on 9/20/02, (90) PCT application US 03/24779, filed on 8/8/03, attorney docket no. 25791.125.02, which claims priority from U.S. provisional patent application serial no. 60/407,442, attorney docket no. 25791.125, filed on 8/30/02, (91) U.S. provisional patent application serial no. 60/423,363, attorney docket no. 25791.126, filed on 12/10/02, (92) U.S. provisional patent application serial no. 60/412,196, attorney docket no. 25791.127, filed on 9/20/02, (93) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.128, filed on 9/20/02, (94) U.S. provisional patent application serial no. 60/412,371, attorney docket no. 25791.129, filed on 9/20/02, (95) U.S. patent application serial no. 10/382,325, attorney docket no. 25791.145, filed on 3/5/03, which is a continuation of U.S. patent number 6,557,640, which was filed as patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, which claims priority from provisional application 60/137,998, filed on 6/7/99, (96) U.S. patent application serial no. 10/624,842, attorney docket no. 25791.151, filed on 7/22/03, which is a divisional of U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, which claims priority from provisional application 60/119,611, filed on 2/11/99, (97) U.S. provisional patent application serial no. 60/431,184, attorney docket no. 25791.157, filed on 12/5/02, (98) U.S. provisional patent application serial no. 60/448,526, attorney docket no. 25791.185, filed on 2/18/03, (99) U.S. provisional patent application serial no. 60/461,539, attorney docket no. 25791.186, filed on 4/9/03, (100) U.S. provisional patent application serial no. 60/462,750, attorney docket no. 25791.193, filed on 4/14/03, (101) U.S. provisional patent application serial no. 60/436,106, attorney docket no. 25791.200, filed on 12/23/02, (102) U.S. provisional patent application serial no. 60/442,942, attorney docket no. 25791.213, filed on 1/27/03, (103) U.S. provisional patent application serial no. 60/442,938, attorney docket no. 25791.225, filed on 1/27/03, (104) U.S. provisional patent application serial no. 60/418,687, attorney docket no. 25791.228, filed on 4/18/03, (105) U.S. provisional patent application serial no. 60/454,896, attorney docket no. 25791.236, filed on 3/14/03, (106) U.S. provisional patent application serial no. 60/450,504, attorney docket no. 25791.238, filed on 2/26/03, (107) U.S. provisional patent application serial no. 60/451,152, attorney docket no. 25791.239, filed on 3/9/03, (108) U.S. provisional

patent application serial no. 60/455,124, attorney docket no. 25791.241, filed on 3/17/03, (109) U.S. provisional patent application serial no. 60/453,678, attorney docket no. 25791.253, filed on 3/11/03, (110) U.S. patent application serial no. 10/421,682, attorney docket no. 25791.256, filed on 4/23/03, which is a continuation of U.S. patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (111) U.S. provisional patent application serial no. 60/457,965, attorney docket no. 25791.260, filed on 3/27/03, (112) U.S. provisional patent application serial no. 60/455,718, attorney docket no. 25791.262, filed on 3/18/03, (113) U.S. patent number 6,550,821, which was filed as patent application serial no. 09/811,734, filed on 3/19/01, (114) U.S. patent application serial no. 10/436,467, attorney docket no. 25791.268, filed on 5/12/03, which is a continuation of U.S. patent number 6,604,763, which was filed as application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, which claims priority from provisional application 60/131,106, filed on 4/26/99, (115) U.S. provisional patent application serial no. 60/459,776, attorney docket no. 25791.270, filed on 4/2/03, (116) U.S. provisional patent application serial no. 60/461,094, attorney docket no. 25791.272, filed on 4/8/03, (117) U.S. provisional patent application serial no. 60/461,038, attorney docket no. 25791.273, filed on 4/7/03, (118) U.S. provisional patent application serial no. 60/463,586, attorney docket no. 25791.277, filed on 4/17/03, (119) U.S. provisional patent application serial no. 60/472,240, attorney docket no. 25791.286, filed on 5/20/03, (120) U.S. patent application serial no. 10/619,285, attorney docket no. 25791.292, filed on 7/14/03, which is a continuation-in-part of U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, which is a continuation-in-part application of U.S. patent no. 6,328,113, which was filed as U.S. Patent Application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/99, which claims priority from provisional application 60/108,558, filed on 11/16/98, (121) U.S. utility patent application serial no. 10/418,688, attorney docket no. 25791.257, which was filed on 4/18/03, as a division of U.S. utility patent application serial no. 09/523,468, attorney docket no. 25791.11.02, filed on 3/10/2000, which claims priority from provisional application 60/124,042, filed on 3/11/99, (122) PCT patent application serial no. PCT/US04/06246, attorney docket no. 25791.238.02, filed on 2/26/2004, (123) PCT patent application serial number PCT/US04/08170 , attorney docket number 25791.40.02, filed on 3/15/04, (124) PCT patent application serial number PCT/US04/08171, attorney docket number 25791.236.02, filed on 3/15/04, (125) PCT patent application serial number PCT/US04/08073, attorney docket number 25791.262.02, filed on 3/18/04, (126) PCT patent application serial number PCT/US04/07711, attorney docket number 25791.253.02, filed on 3/11/2004, (127) PCT patent application serial number PCT/US04/_____, attorney docket number 25791.260.02, filed on 3/26/2004, (128)

PCT patent application serial number PCT/US04/_____, attorney docket number 25791.270.02, filed on 4/2/2004, (129) PCT patent application serial number PCT/US04/_____, attorney docket number 25791.272.02, filed on 4/7/2004, and (130) PCT patent application serial number PCT/US04/_____, attorney docket number 25791.273.02, filed on 4/6/2004, the disclosures of which are incorporated herein by reference.

**[0032]** In several alternative embodiments, the exemplary embodiments of Figs. 1a, 1ba, 1bb, 1bc, 1bd, 1be, 1bf, 1c, 1d, 1e, 2a, 2b, and 2c are implemented using an expansion mandrel 20 that includes conventional rotary and/or roller expansion elements such as, for example, that disclosed in WO 02/082863, U.S. 6,457,532, and/or U.S. 2002/0139540, the disclosures of which are incorporated herein by reference, or any one of the commercially available roller expansion devices available from Weatherford International.

**[0033]** An apparatus for radially expanding a tubular member and drilling a wellbore within a subterranean formation has been described that includes an expandable tubular member, an expansion device coupled to the expandable tubular member adapted to radially expand and plastically deform the expandable tubular member within the wellbore including: a tubular expansion mandrel, and a tubular expansion mandrel launcher for housing the tubular expansion mandrel coupled to the expandable tubular member, a pump coupled to the expansion device adapted to pump fluidic materials through the tubular expansion mandrel into a portion of the tubular expansion mandrel launcher, a drilling device coupled to the expansion device adapted to receive the fluidic materials pumped into the portion of the tubular expansion mandrel launcher and drill the wellbore within the subterranean formation including: one or more flow control elements for controlling the flow of the received fluidic materials, a motor coupled to the flow control elements adapted to be operated by the fluidic materials, and a drill coupled to the motor adapted to be driven by the motor, and a controller coupled to the expansion device and the drilling device that is programmed to control the expansion device and the drilling device to operate in one of the following modes of operation: (a) drilling the wellbore using the drilling device or expanding the tubular member using the expansion device, or (b) drilling the wellbore using the drilling device and expanding the tubular member using the expansion device simultaneously. In an exemplary embodiment, the operational characteristics of the flow control elements vary as a function of the operational characteristics of the pumped fluidic materials. In an exemplary embodiment, the operational characteristics of the flow control elements include a resistance to flow of the fluidic materials. In an exemplary embodiment, the operational characteristics of the pumped fluidic materials include a frequency component.

**[0034]** A method of radially expanding a wellbore casing within a wellbore and drilling the wellbore through a subterranean formation has been described that includes positioning an

expandable casing, an expansion device for radially expanding the expandable casing, and a drilling device for extending the wellbore within the wellbore, and operating the expansion device and the drilling device using a method including: selecting drilling or expanding or drilling and expanding, if drilling or expanding is selected, then sequentially performing the following steps in any order: extending the wellbore using the drilling device, and expanding the casing using the expansion device, and if drilling and expanding is selected, then simultaneously performing the following steps: extending the wellbore using the drilling device, and expanding the casing using the expansion device. In an exemplary embodiment, the expansion device includes an expansion mandrel. In an exemplary embodiment, the expansion device includes a rotating expansion device.

**[0035]** A system for radially expanding a wellbore casing within a wellbore and drilling the wellbore through a subterranean formation has been described that includes means for positioning an expandable casing, an expansion device for radially expanding the expandable casing, and a drilling device for extending the wellbore within the wellbore, and means for operating the expansion device and the drilling device including: means for selecting drilling or expanding or drilling and expanding, if drilling or expanding is selected, then means for sequentially performing the following steps in any order: extending the wellbore using the drilling device, and expanding the casing using the expansion device, and if drilling and expanding is selected, then means for simultaneously performing the following steps: extending the wellbore using the drilling device, and expanding the casing using the expansion device.

**[0036]** An apparatus for radially expanding a tubular member and drilling a wellbore within a subterranean formation has been described that includes an expandable tubular member, an expansion device coupled to the expandable tubular member adapted to radially expand and plastically deform the expandable tubular member within the wellbore, a drilling device coupled to the expansion device adapted to drill the wellbore within the subterranean formation, and a controller coupled to the expansion device and the drilling device that is programmed to control the expansion device and the drilling device to operate in one of the following modes of operation: (a) drilling the wellbore using the drilling device or expanding the tubular member using the expansion device; or (b) drilling the wellbore using the drilling device and expanding the tubular member using the expansion device simultaneously. In an exemplary embodiment, the expansion device includes an expansion mandrel. In an exemplary embodiment, the expansion device includes an expansion mandrel. In an exemplary embodiment, the controller includes one or more flow control elements whose operational characteristics are frequency dependent.

**[0037]** It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, the teachings of the present illustrative

embodiments may be used to provide a wellbore casing, a pipeline, or a structural support. Furthermore, the underreamer 40 and/or the bit 46 may be omitted and/or replaced by equivalent devices.

**[0038]** Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

## Claims

What is claimed is:

1. An apparatus for radially expanding a tubular member and drilling a wellbore within a subterranean formation, comprising:

an expandable tubular member;

an expansion device coupled to the expandable tubular member adapted to radially expand and plastically deform the expandable tubular member within the wellbore comprising:

a tubular expansion mandrel; and

a tubular expansion mandrel launcher for housing the tubular expansion mandrel coupled to the expandable tubular member;

a pump coupled to the expansion device adapted to pump fluidic materials through the tubular expansion mandrel into a portion of the tubular expansion mandrel launcher;

a drilling device coupled to the expansion device adapted to receive the fluidic materials pumped into the portion of the tubular expansion mandrel launcher and drill the wellbore within the subterranean formation comprising:

one or more flow control elements for controlling the flow of the received fluidic materials;

a motor coupled to the flow control elements adapted to be operated by the fluidic materials; and

a drill coupled to the motor adapted to be driven by the motor; and

a controller coupled to the expansion device and the drilling device that is programmed to control the expansion device and the drilling device to operate in one of the following modes of operation: (a) drilling the wellbore using the drilling device or expanding the tubular member using the expansion device; or (b) drilling the wellbore using the drilling device and expanding the tubular member using the expansion device simultaneously.

2. The apparatus of claim 1, wherein the operational characteristics of the flow control elements vary as a function of the operational characteristics of the pumped fluidic materials.

3. The apparatus of claim 2, wherein the operational characteristics of the flow control elements comprise a resistance to flow of the fluidic materials.

4. The apparatus of claim 2, wherein the operational characteristics of the pumped fluidic materials comprise a frequency dependent component.

5. A method of radially expanding a wellbore casing within a wellbore and drilling the wellbore through a subterranean formation, comprising:

positioning an expandable casing, an expansion device for radially expanding the expandable casing, and a drilling device for extending the wellbore within the wellbore; and

operating the expansion device and the drilling device using a method comprising:

selecting drilling or expanding or drilling and expanding;

if drilling or expanding is selected, then sequentially performing the following steps in any order:

extending the wellbore using the drilling device; and

expanding the casing using the expansion device; and

if drilling and expanding is selected, then simultaneously performing the following steps:

extending the wellbore using the drilling device; and

expanding the casing using the expansion device.

6. The method of claim 5, wherein the expansion device comprises an expansion mandrel.

7. The method of claim 5, wherein the expansion device comprises a rotating expansion device.

8. The method of claim 5, further comprising:

varying the operational characteristics of at least one of the drilling device and the expansion device as a function of the operational characteristics of pumped fluidic materials.

9. The method of claim 8, wherein the operational characteristics of at least one of the drilling device and the expansion device comprise a resistance to flow of the fluidic materials.

10. The method of claim 8, wherein the operational characteristics of at least one of the drilling device and the expansion device comprise a frequency dependent component.

11. A system for radially expanding a wellbore casing within a wellbore and drilling the wellbore through a subterranean formation, comprising:

means for positioning an expandable casing, an expansion device for radially expanding the expandable casing, and a drilling device for extending the wellbore within the wellbore; and

means for operating the expansion device and the drilling device comprising:

means for selecting drilling or expanding or drilling and expanding;

if drilling or expanding is selected, then means for sequentially performing the following steps in any order:

extending the wellbore using the drilling device; and

expanding the casing using the expansion device; and

if drilling and expanding is selected, then means for simultaneously performing the following steps:

extending the wellbore using the drilling device; and

expanding the casing using the expansion device.

12. The system of claims 11, further comprising:

means for varying the operational characteristics of at least one of the drilling device and the expansion device as a function of the operational characteristics of the pumped fluidic materials.

13. The system of claim 12, wherein the operational characteristics of at least one of the drilling device and the expansion device comprise a resistance to flow of the fluidic materials.

14. The system of claim 12, wherein the operational characteristics of at least one of the drilling device and the expansion device comprise a frequency dependent component.

15. An apparatus for radially expanding a tubular member and drilling a wellbore within a subterranean formation, comprising:

an expandable tubular member;

an expansion device coupled to the expandable tubular member adapted to radially expand and plastically deform the expandable tubular member within the wellbore;

a drilling device coupled to the expansion device adapted to drill the wellbore within the subterranean formation; and

a controller coupled to the expansion device and the drilling device that is

programmed to control the expansion device and the drilling device to operate in one of the following modes of operation: (a) drilling the wellbore using the drilling device or expanding the tubular member using the expansion device; or (b) drilling the wellbore using the drilling device and expanding the tubular member using the expansion device simultaneously.

16. The apparatus of claim 15, wherein the expansion device comprises an expansion mandrel.

17. The apparatus of claim 15, wherein the expansion device comprises a rotating expansion device.

18. The apparatus of claim 15, wherein the controller comprises one or more flow control elements whose operational characteristics are frequency dependent.

19. An apparatus for radially expanding a tubular member and drilling a wellbore within a subterranean formation, comprising:

an expandable tubular member;

an expansion device coupled to the expandable tubular member adapted to radially expand and plastically deform the expandable tubular member within the wellbore comprising:

a tubular expansion mandrel; and

a tubular expansion mandrel launcher for housing the tubular expansion mandrel coupled to the expandable tubular member;

a pump coupled to the expansion device adapted to pump fluidic materials through the tubular expansion mandrel into a portion of the tubular expansion mandrel launcher;

a drilling device coupled to the expansion device adapted to receive the fluidic materials pumped into the portion of the tubular expansion mandrel launcher and drill the wellbore within the subterranean formation comprising:

one or more flow control elements for controlling the flow of the received fluidic materials;

a motor coupled to the flow control elements adapted to be operated by the fluidic materials; and

a drill coupled to the motor adapted to be driven by the motor; and

a controller coupled to the expansion device and the drilling device that is programmed to control the expansion device and the drilling device to operate

in one of the following modes of operation: (a) drilling the wellbore using the drilling device or expanding the tubular member using the expansion device; or (b) drilling the wellbore using the drilling device and expanding the tubular member using the expansion device simultaneously;

wherein the operational characteristics of the flow control elements vary as a function of the operational characteristics of the pumped fluidic materials;

wherein the operational characteristics of the flow control elements comprise a resistance to flow of the fluidic materials; and

wherein the operational characteristics of the pumped fluidic materials comprise a frequency component.

20. A method of radially expanding a wellbore casing within a wellbore and drilling the wellbore through a subterranean formation, comprising:

positioning an expandable casing, an expansion device for radially expanding the expandable casing, and a drilling device for extending the wellbore within the wellbore; and

operating the expansion device and the drilling device using a method comprising:

selecting drilling or expanding or drilling and expanding;

if drilling or expanding is selected, then sequentially performing the following steps in any order:

extending the wellbore using the drilling device; and

expanding the casing using the expansion device;

if drilling and expanding is selected, then simultaneously performing the following steps:

extending the wellbore using the drilling device; and

expanding the casing using the expansion device; and

varying the operational characteristics of at least one of the drilling device and the expansion device as a function of the operational characteristics of pumped fluidic materials;

wherein the operational characteristics of at least one of the drilling device and the expansion device comprise a resistance to flow of the fluidic materials; and

wherein the operational characteristics of at least one of the drilling device and the expansion device comprise a frequency dependent component.

21. A system for radially expanding a wellbore casing within a wellbore and drilling the wellbore through a subterranean formation, comprising:

means for positioning an expandable casing, an expansion device for radially

expanding the expandable casing, and a drilling device for extending the wellbore within the wellbore;

means for operating the expansion device and the drilling device comprising:

means for selecting drilling or expanding or drilling and expanding;

if drilling or expanding is selected, then means for sequentially performing the following steps in any order:

extending the wellbore using the drilling device; and

expanding the casing using the expansion device; and

if drilling and expanding is selected, then means for simultaneously performing the following steps:

extending the wellbore using the drilling device; and

expanding the casing using the expansion device; and

means for varying the operational characteristics of at least one of the drilling device and the expansion device as a function of the operational characteristics of pumped fluidic materials;

wherein the operational characteristics of at least one of the drilling device and the expansion device comprise a resistance to flow of the fluidic materials; and

wherein the operational characteristics of at least one of the drilling device and the expansion device comprise a frequency dependent component.

22. An apparatus for radially expanding a tubular member and drilling a wellbore within a subterranean formation, comprising:

an expandable tubular member;

an expansion device coupled to the expandable tubular member adapted to radially expand and plastically deform the expandable tubular member within the wellbore;

a drilling device coupled to the expansion device adapted to drill the wellbore within the subterranean formation; and

a controller coupled to the expansion device and the drilling device that is programmed to control the expansion device and the drilling device to operate in one of the following modes of operation: (a) drilling the wellbore using the drilling device or expanding the tubular member using the expansion device; or (b) drilling the wellbore using the drilling device and expanding the tubular member using the expansion device simultaneously;

wherein the controller comprises one or more flow control elements whose operational characteristics are frequency dependent.

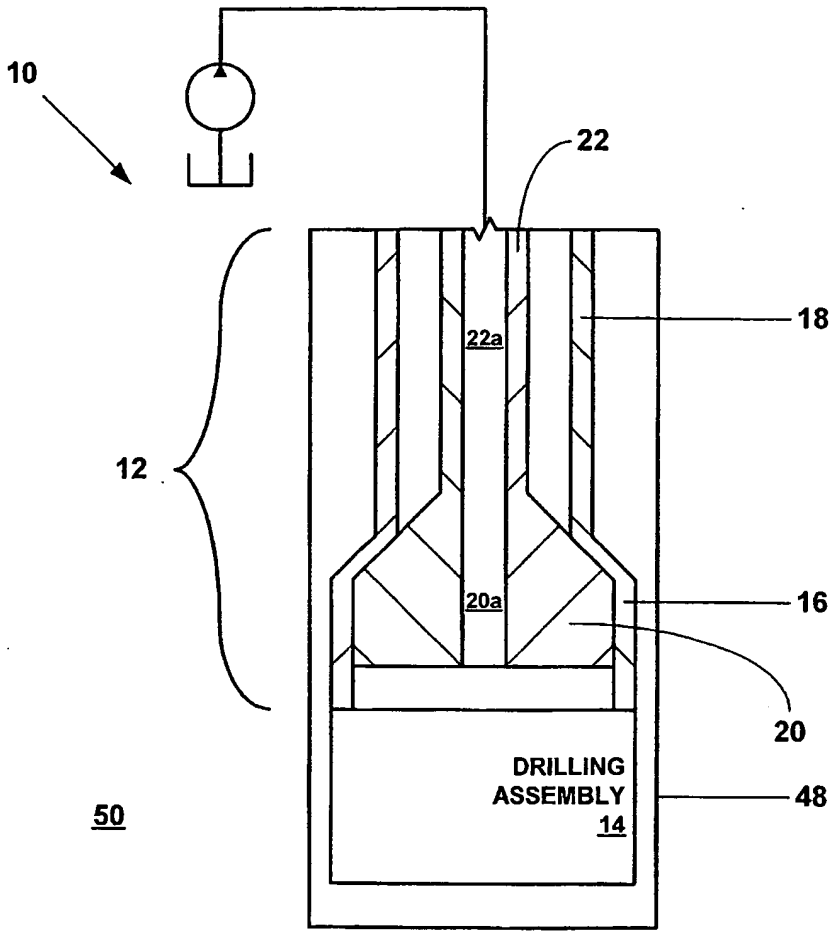
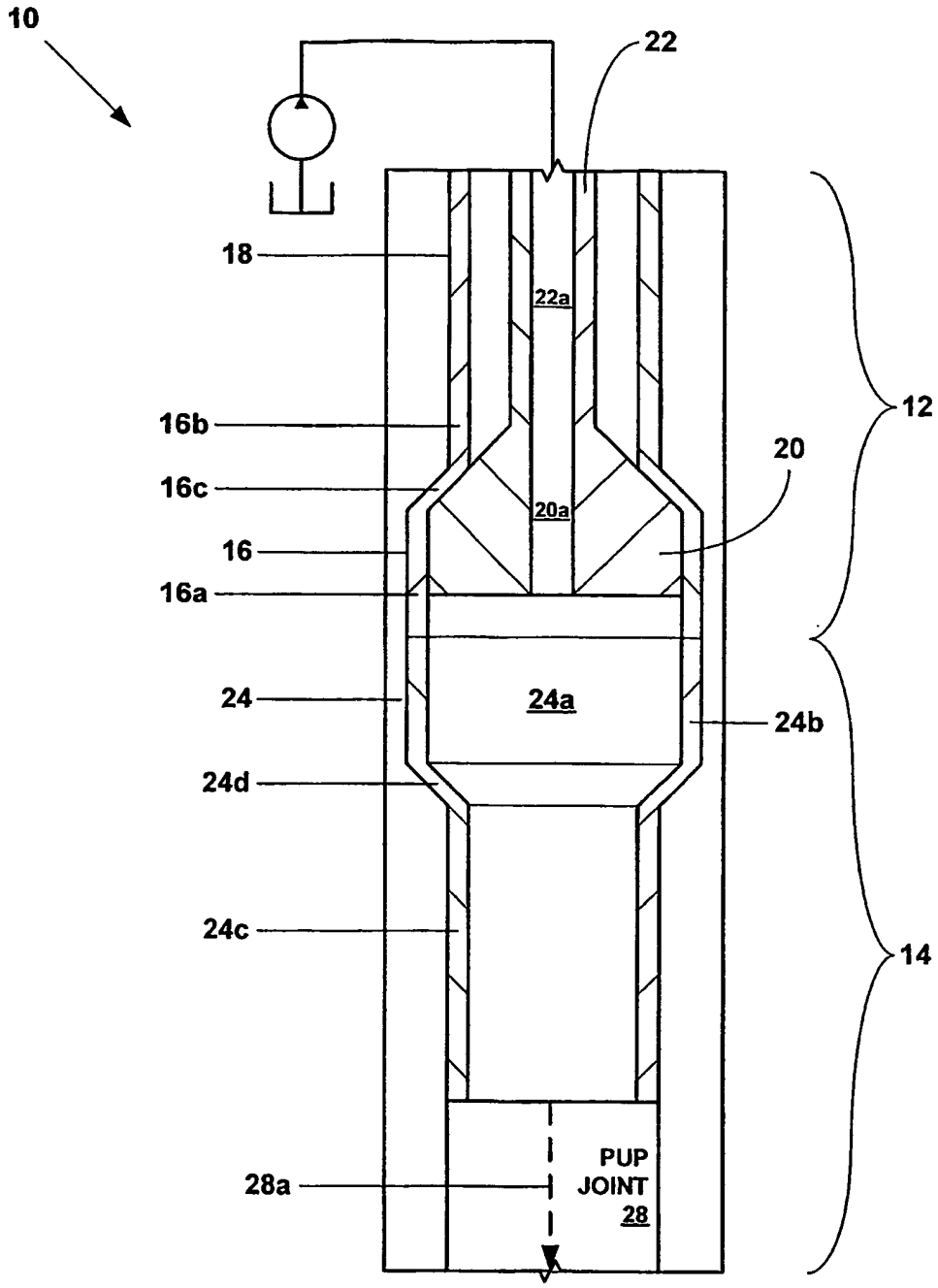
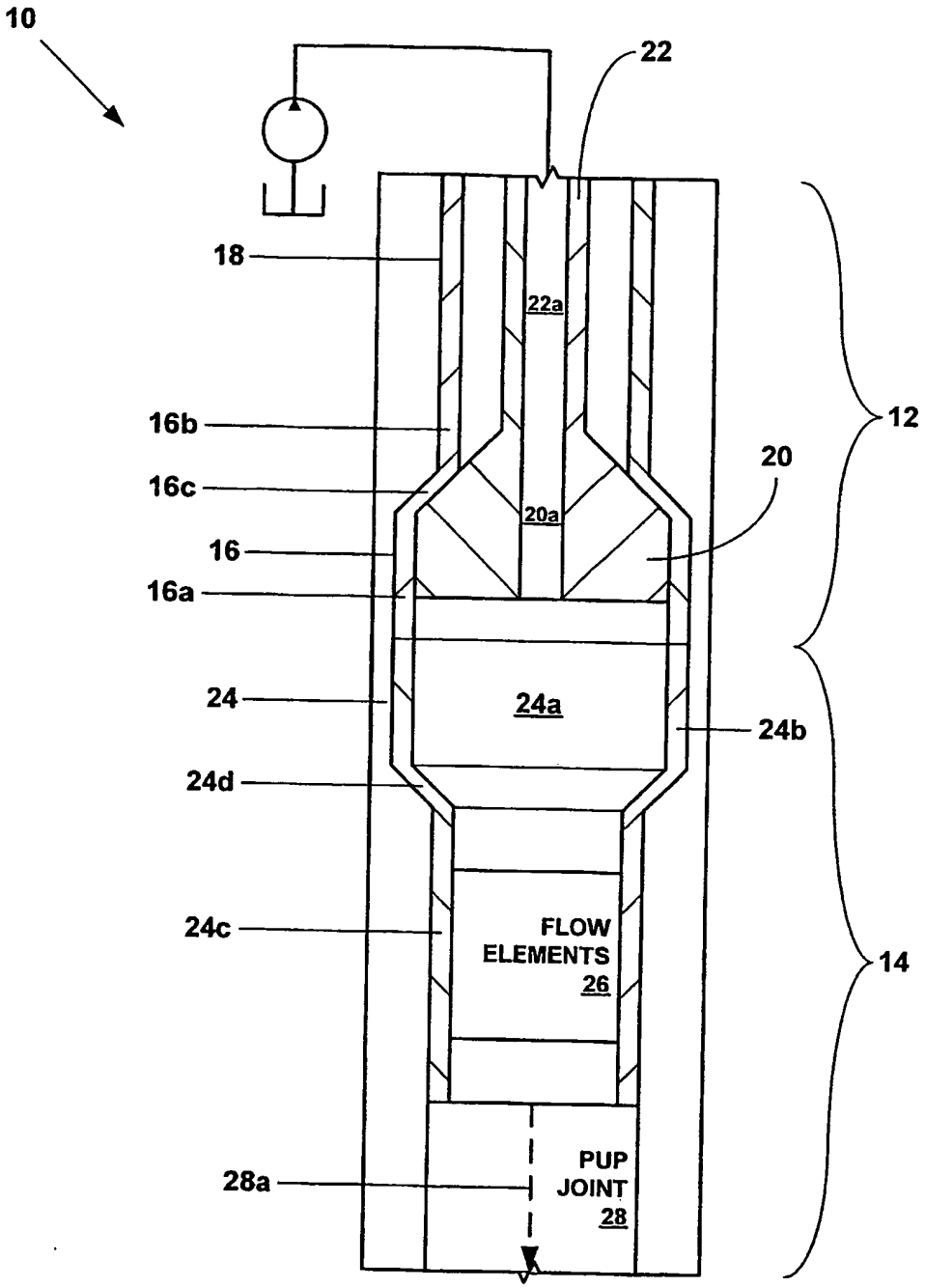



Fig. 1a


10
22
18
22a
16b
16c
16
16a
20
20a
12
24
24a
24b
24d
24c
14
28a
PUP
JOINT
28


10
22
18
22a
16b
16c
16
16a
20
20a
12
24
24a
24b
24d
24c
FLOW
ELEMENTS
26
14
28a
PUP
JOINT
28

Page 1bb

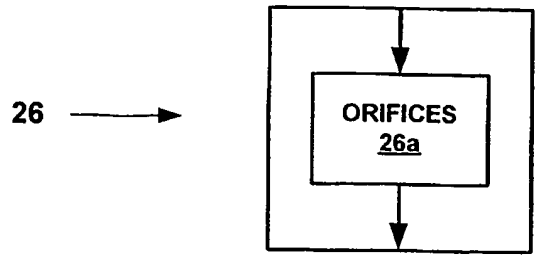



Fig. 1bc

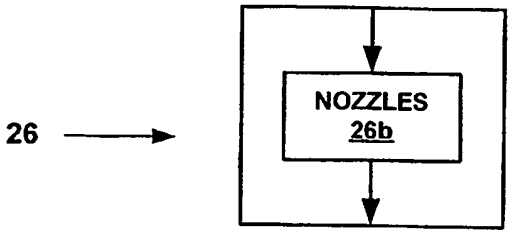



Fig. 1bd

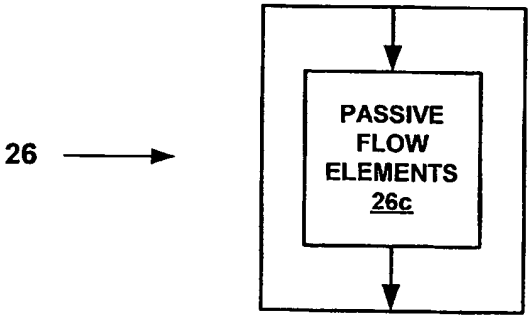



Fig. 1be

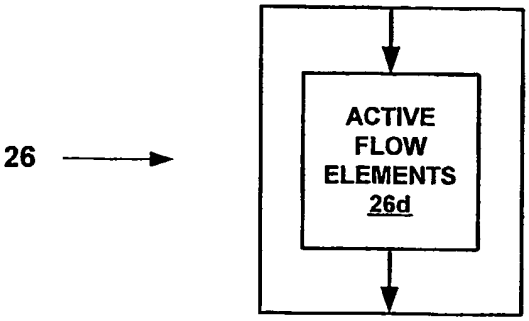



Fig. 1bf

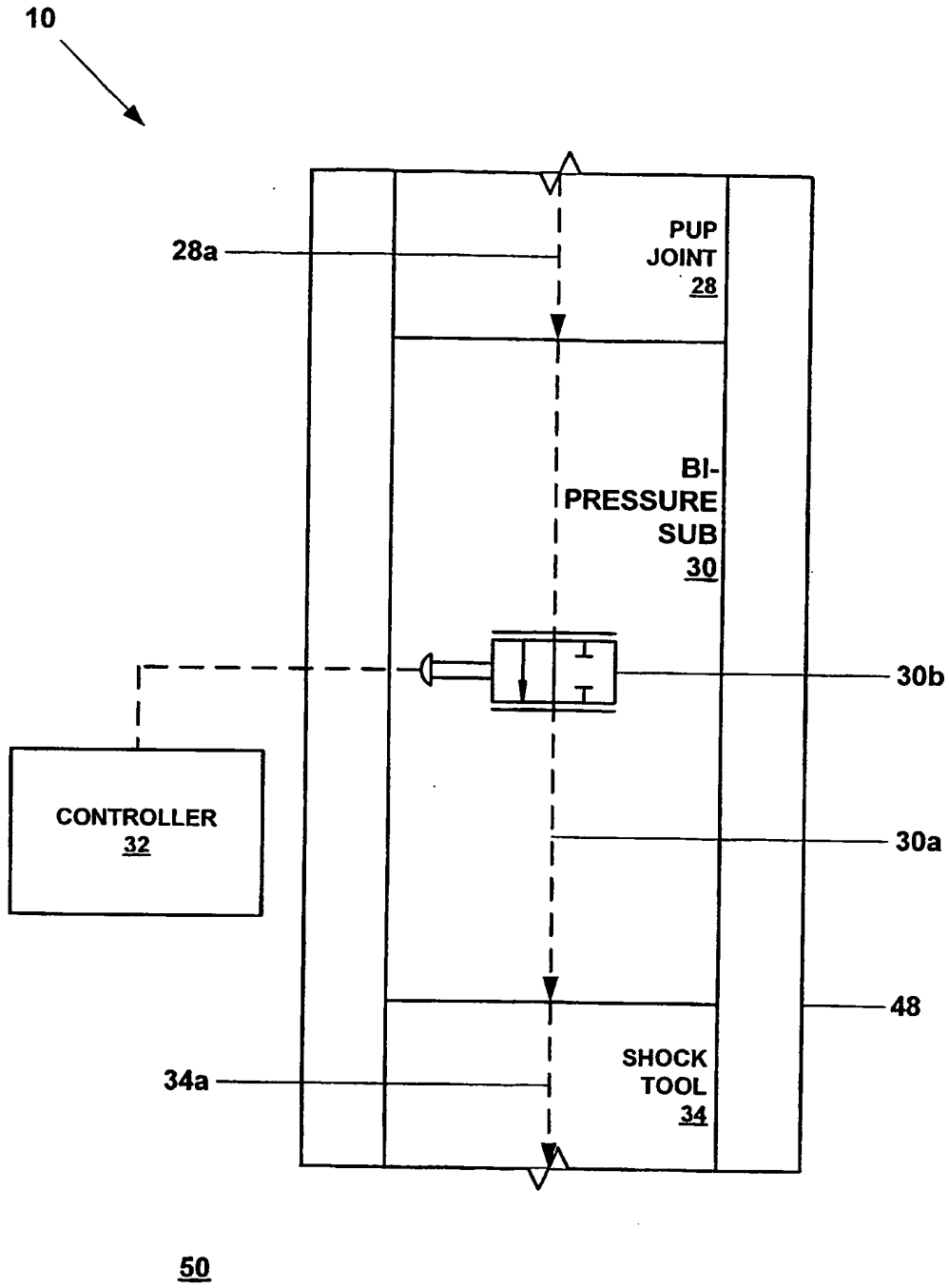

10
28a
PUP
JOINT
28
BI-
PRESSURE
SUB
30
30b
CONTROLLER
32
30a
48
34a
SHOCK
TOOL
34
50

Fig. 1c

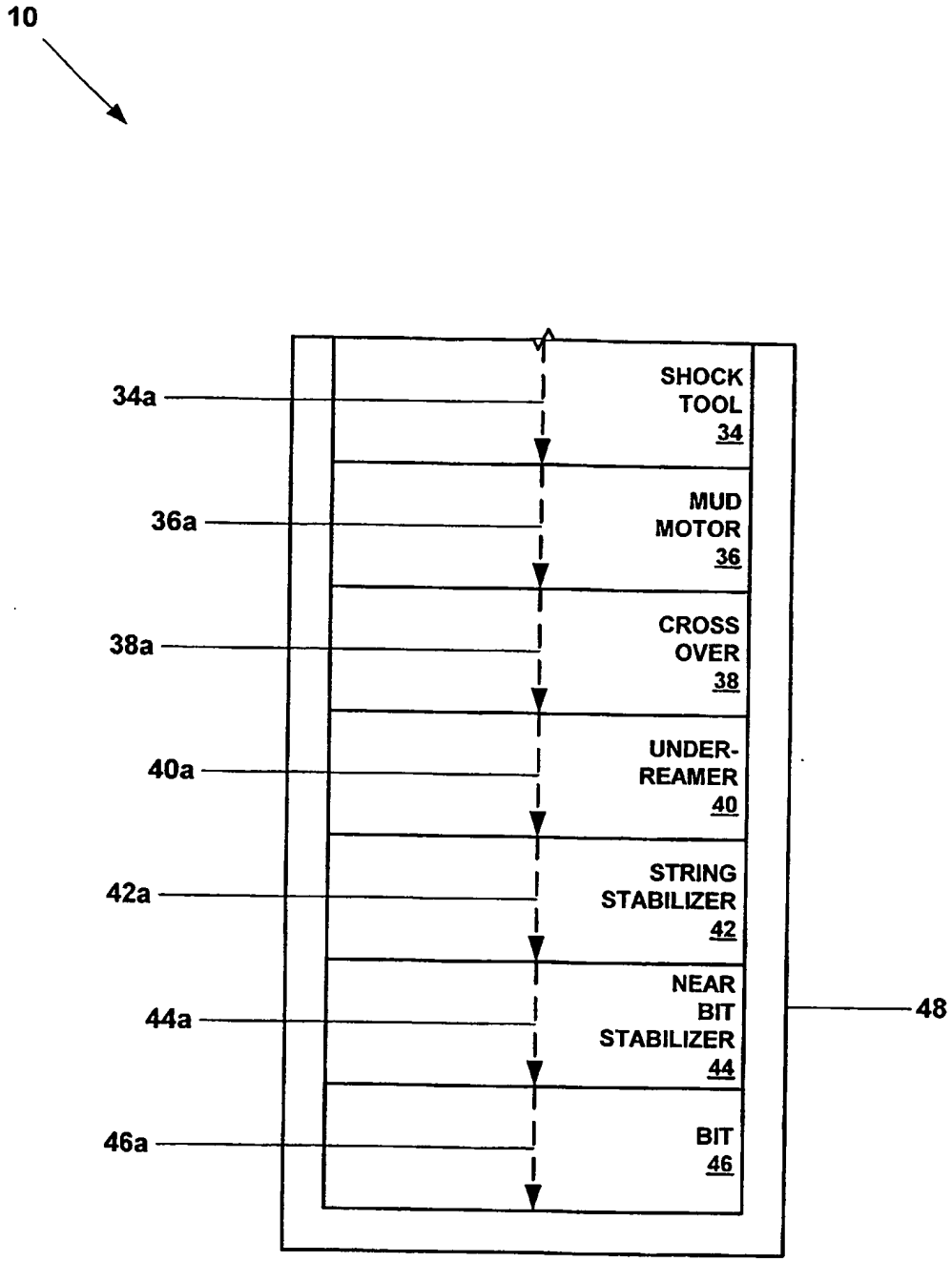

10
34a
SHOCK TOOL 34
36a
MUD MOTOR 36
38a
CROSS OVER 38
40a
UNDER-REAMER 40
42a
STRING STABILIZER 42
44a
NEAR BIT STABILIZER 44
46a
BIT 46
48
50

Fig. 1d

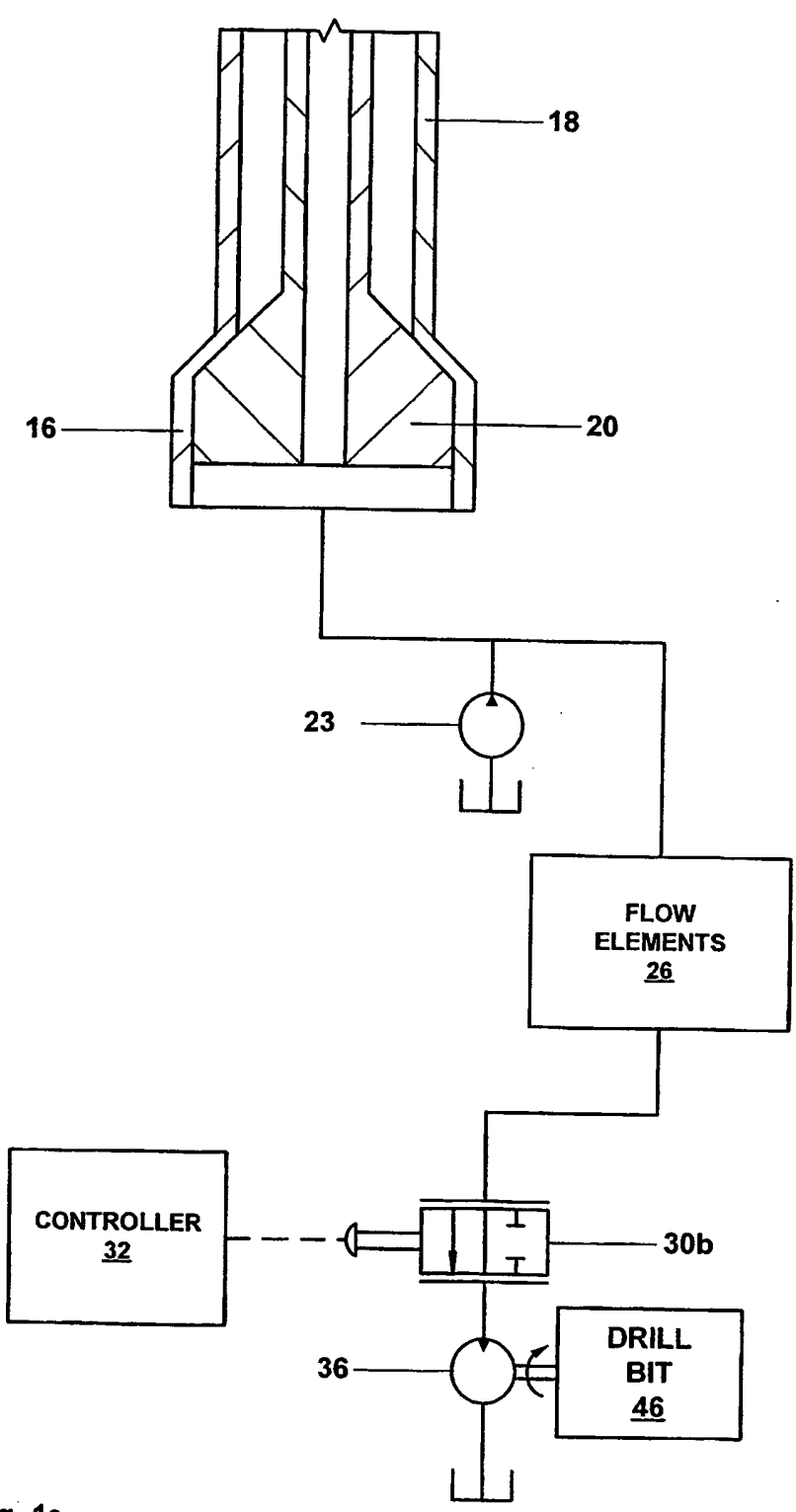

10
18
16
20
23
FLOW
ELEMENTS
26
CONTROLLER
32
30b
36
DRILL
BIT
46

Fig. 1e

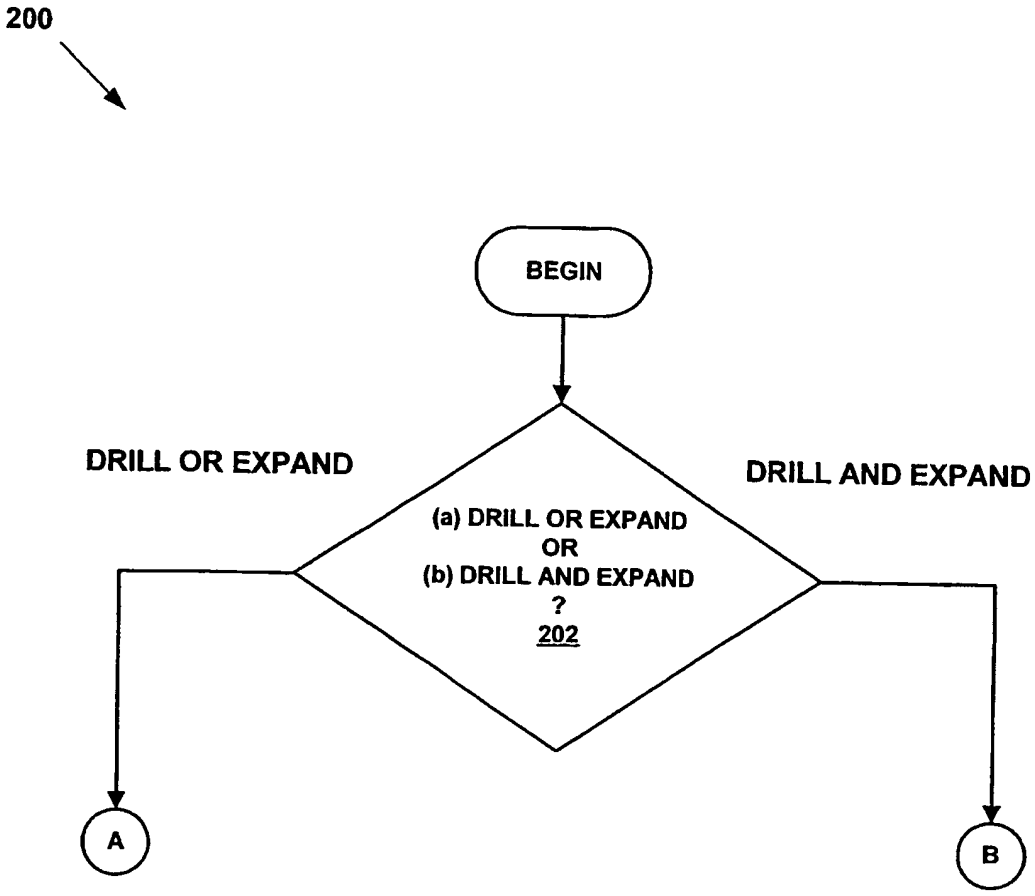

200
BEGIN
DRILL OR EXPAND
DRILL AND EXPAND
(a) DRILL OR EXPAND
OR
(b) DRILL AND EXPAND
?
202
A
B

Fig. 2a

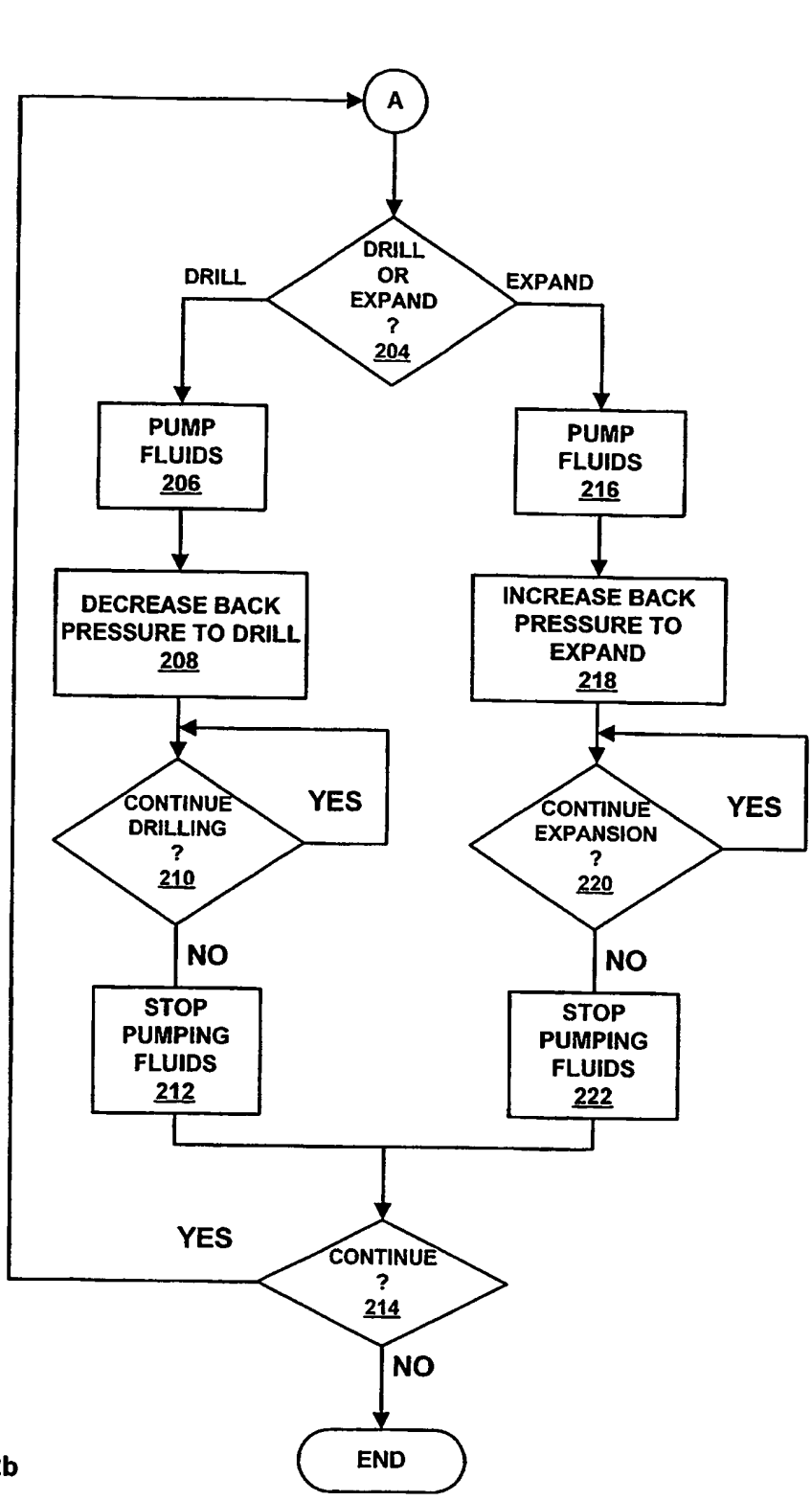

200
A
DRILL OR EXPAND ? 204
DRILL
EXPAND
PUMP FLUIDS 206
PUMP FLUIDS 216
DECREASE BACK PRESSURE TO DRILL 208
INCREASE BACK PRESSURE TO EXPAND 218
CONTINUE DRILLING ? 210
YES
CONTINUE EXPANSION ? 220
YES
NO
NO
STOP PUMPING FLUIDS 212
STOP PUMPING FLUIDS 222
YES
CONTINUE ? 214
NO
END

Fig. 2b

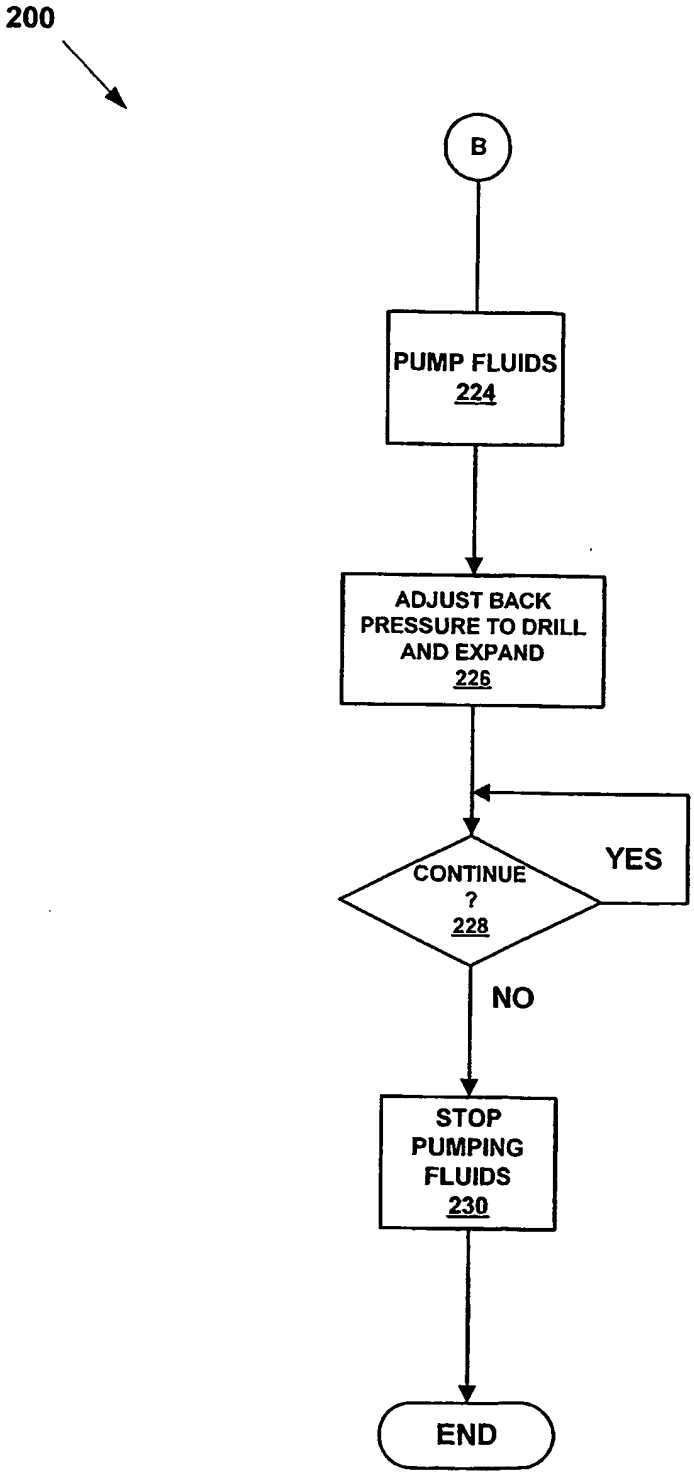

200
B
PUMP FLUIDS
224
ADJUST BACK PRESSURE TO DRILL AND EXPAND
226
CONTINUE ?
228
YES
NO
STOP PUMPING FLUIDS
230
END

Fig. 2c